b
UNIVERSITÄT
BERN

SwissSenseSynergy: Secure Localization and Privacy-Preserving Location-Based Services

Andreea Hossmann-Picu
Universität Bern, Switzerland

March 30, 2015

The SwissSenseSynergy Project

- three years (01.2015–12.2017), ~1M CHF
- four partners
  - University of Berne (project coordinator)
    ⇝ *Prof. Torsten Braun*
  - University of Geneva ⇝ *Prof. José Rolim*
  - SUPSI (U. of Applied Sciences & Arts of S Switz.)
    ⇝ *Prof. Silvia Giordano*
  - Chalmers University ⇝ *Prof. Aikaterini Mitrokotsa, Dr. Christos Dimitrakakis*
- four SNF PhD students 60% ⇝ one per partner
- one SNF postdoc 100%
  ⇝ split 40-30-30% among the first three partners

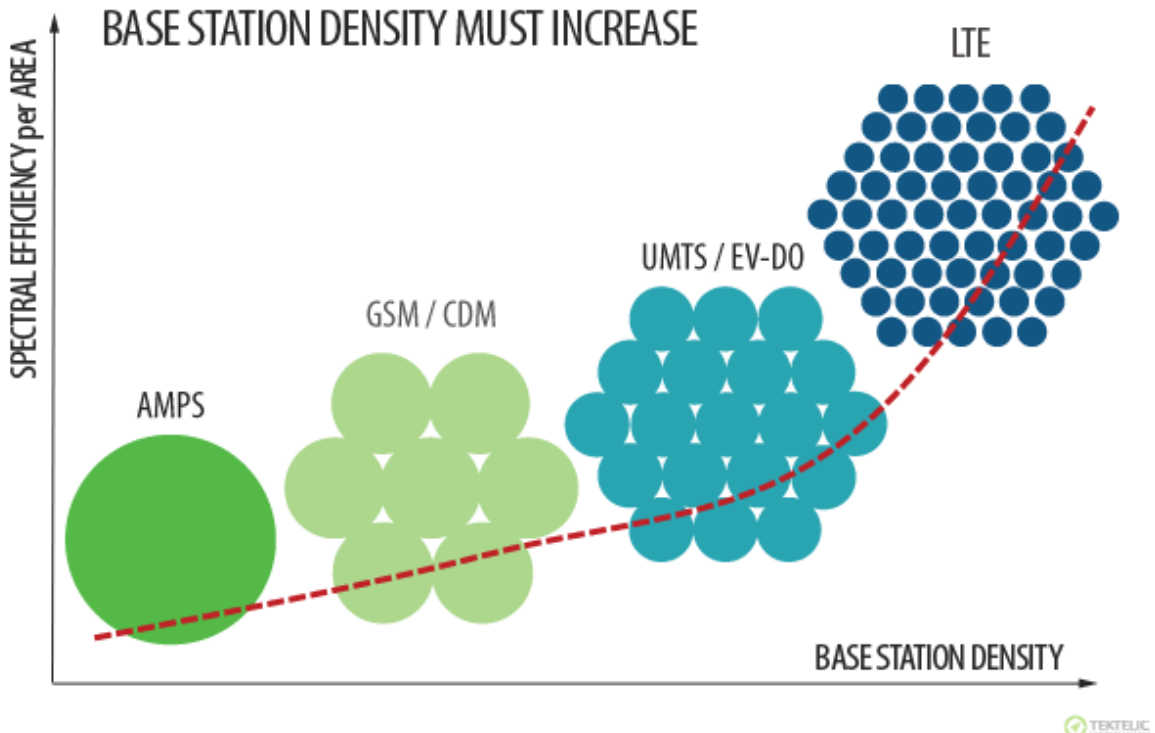
Outline

Outline
Motivation
SwissSenseSynergy: Project Overview
From Data to Insights
Using the Insights

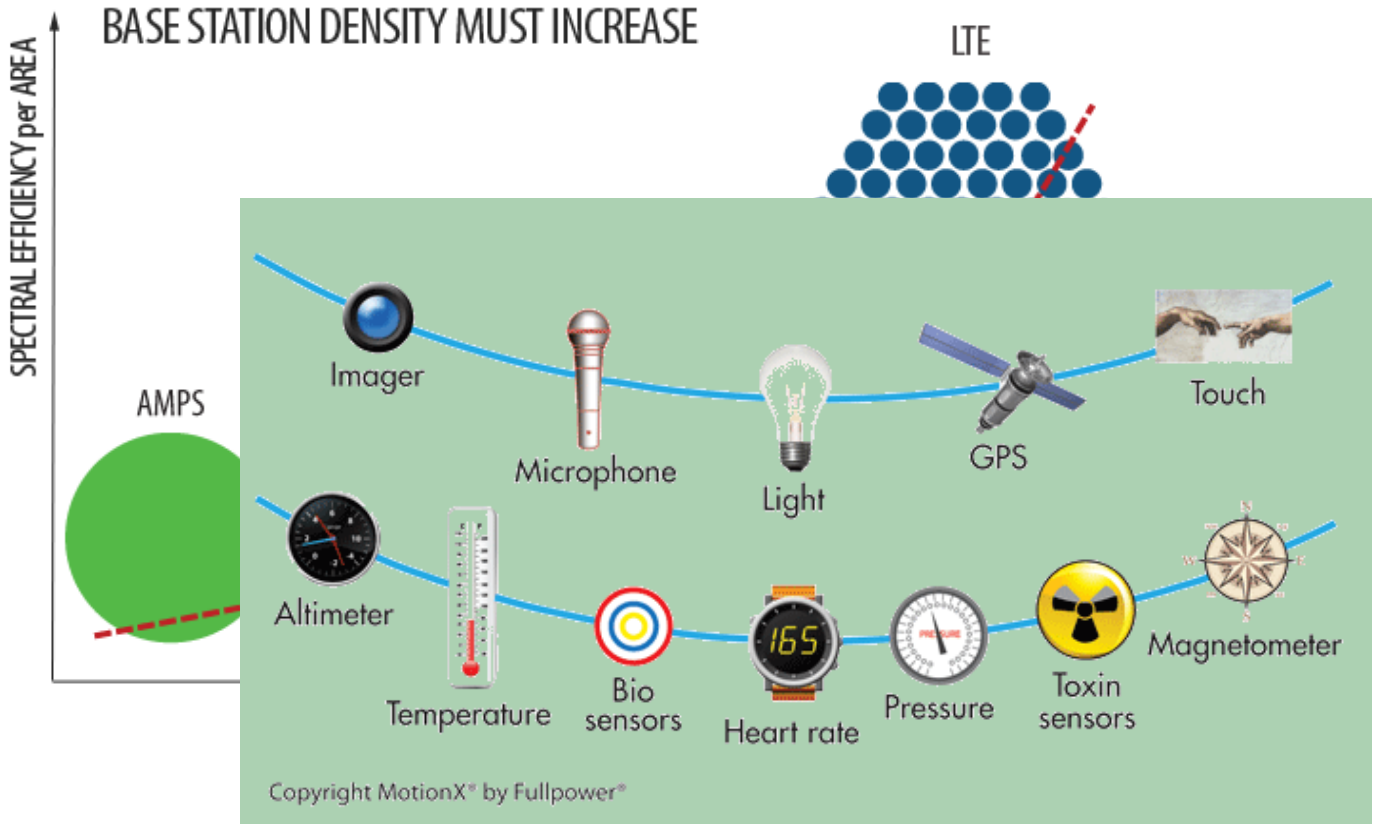
SwissSenseSynergy: Motivation

SwissSenseSynergy: Motivation

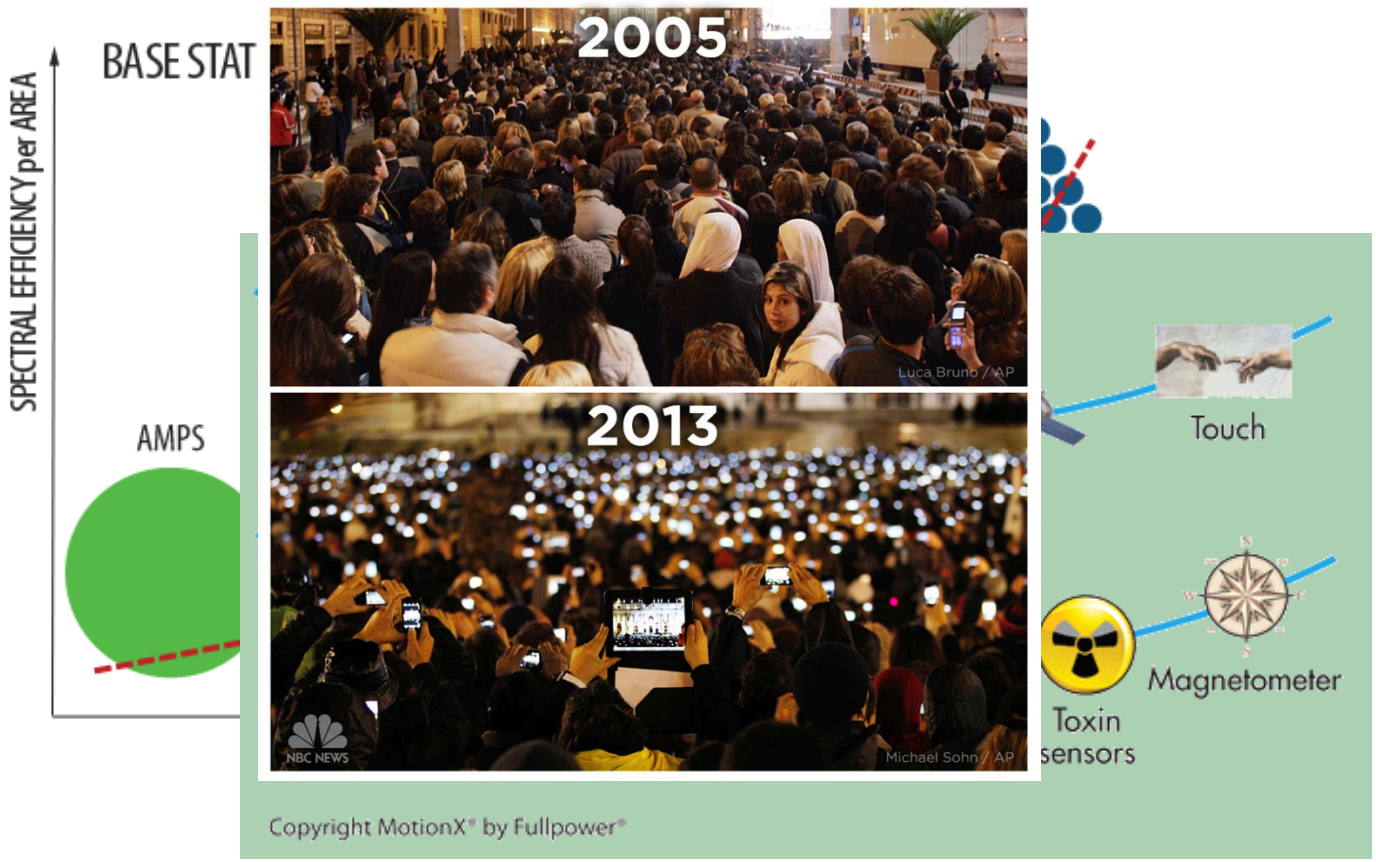
SwissSenseSynergy: Motivation



SwissSenseSynergy: Motivation



SwissSenseSynergy: Motivation

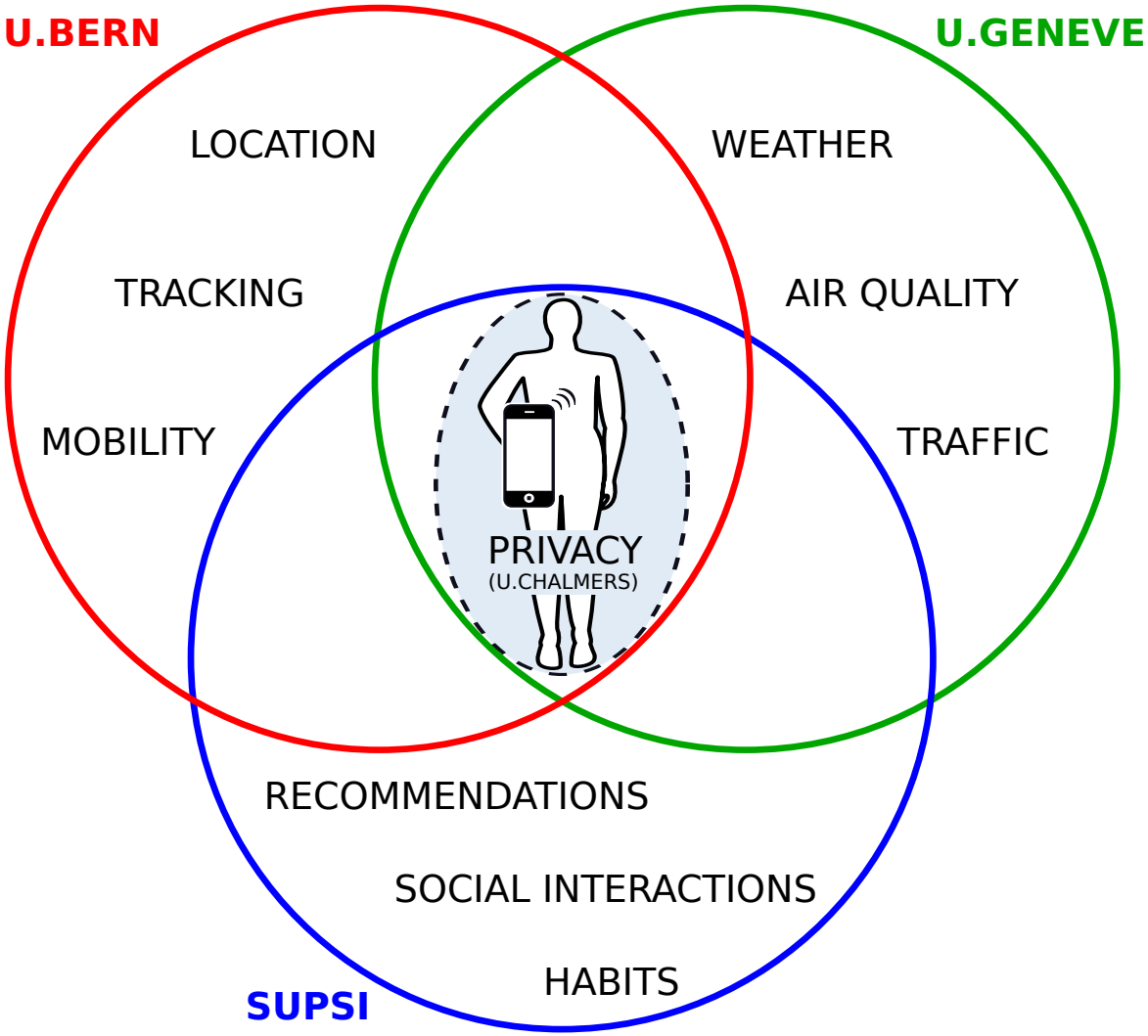


SwissSenseSynergy: Goal

Secure localization and location-based services (LBS)

- highly personalized navigation service
- customized coupon dispensing system
- etc

SwissSenseSynergy: Project Overview



U. Bern Subproject: MobLocator

1. Localization and tracking [Zan and Marcel]
   - Femto cells = anchor nodes
   - High density ⇒ better accuracy
   - Fine grained mobility model/prediction

U. Bern Subproject: MobLocator

UNIVERSITÄT BERN

1. Localization and tracking [Zan and Marcel]
   - Femto cells = anchor nodes
   - High density ⇒ better accuracy
   - Fine grained mobility model/prediction
2. Wireless network planning [Andreea]
   - Location, social, environment profile
     ⇒ advanced (mobility, behavior) prediction
   - User location/mobility ⇒ improved handovers
   - Usage profile ⇒ dynamic radio resource alloc.

U. Bern Subproject: MobLocator

UNIVERSITÄT BERN

1. Localization and tracking [Zan and Marcel]
   - Femto cells = anchor nodes
   - High density ⇒ better accuracy
   - Fine grained mobility model/prediction
2. Wireless network planning [Andreea]
   - Location, social, environment profile
     ⇒ advanced (mobility, behavior) prediction
   - User location/mobility ⇒ improved handovers
   - Usage profile ⇒ dynamic radio resource alloc.
3. Wireless network access
   - Location profile ⇒ access rights

U. Bern Subproject: MobLocator

1. Localization and tracking [Zan and Marcel]
   - Femto cells = anchor nodes
   - High density ⇒ better accuracy
   - Fine grained mobility model/prediction

2. Wireless network planning [Andreea]
   - Location, social, environment profile
     ⇒ advanced (mobility, behavior) prediction
   - User location/mobility ⇒ improved handovers
   - Usage profile ⇒ dynamic radio resource alloc.

3. Wireless network access
   - Location profile ⇒ access rights

From Data to Insights

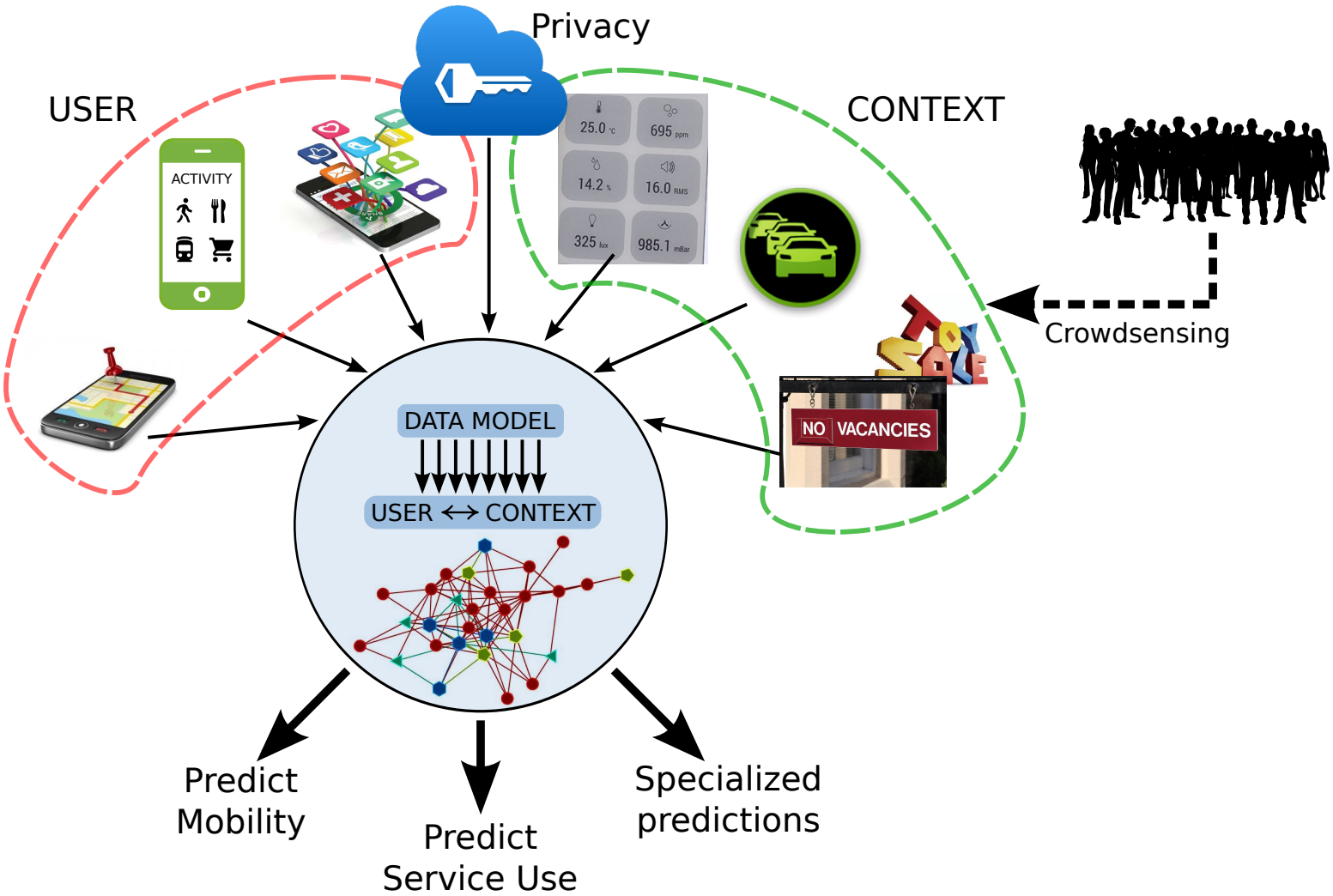
User Data (from mobile phones)

- location and mobility
- activity
- social, behavioral, demographic

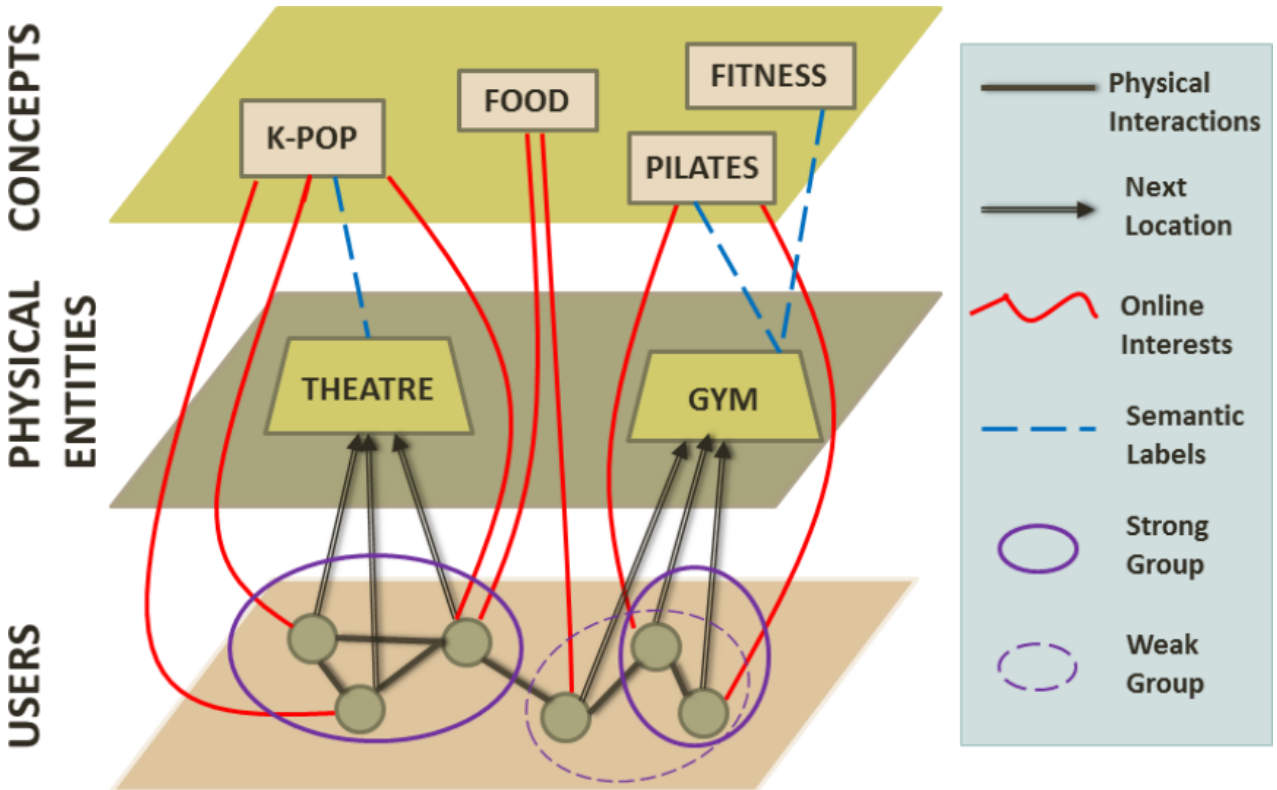
Context Data (from sensors and crowdsensing)

- environment (weather, air quality etc.)
- infrastructure (traffic, schedules etc.)
- specialized (in retail – items on sale etc.)

From Data to Insights



Data Model: User Data



*from [Misra et al. 2014]

Data Model: Issues

- What about context data?
- New types of nodes (states of the context):
  - rain, pollen, noise etc
  - car accident, conductors' strike etc
  - application-specific nodes
- New types of links:
  - causality (e.g. "skip tennis practice *due to* rain")
  - location of context (e.g. "car accident *near* exit 3")
  - links among more than two nodes

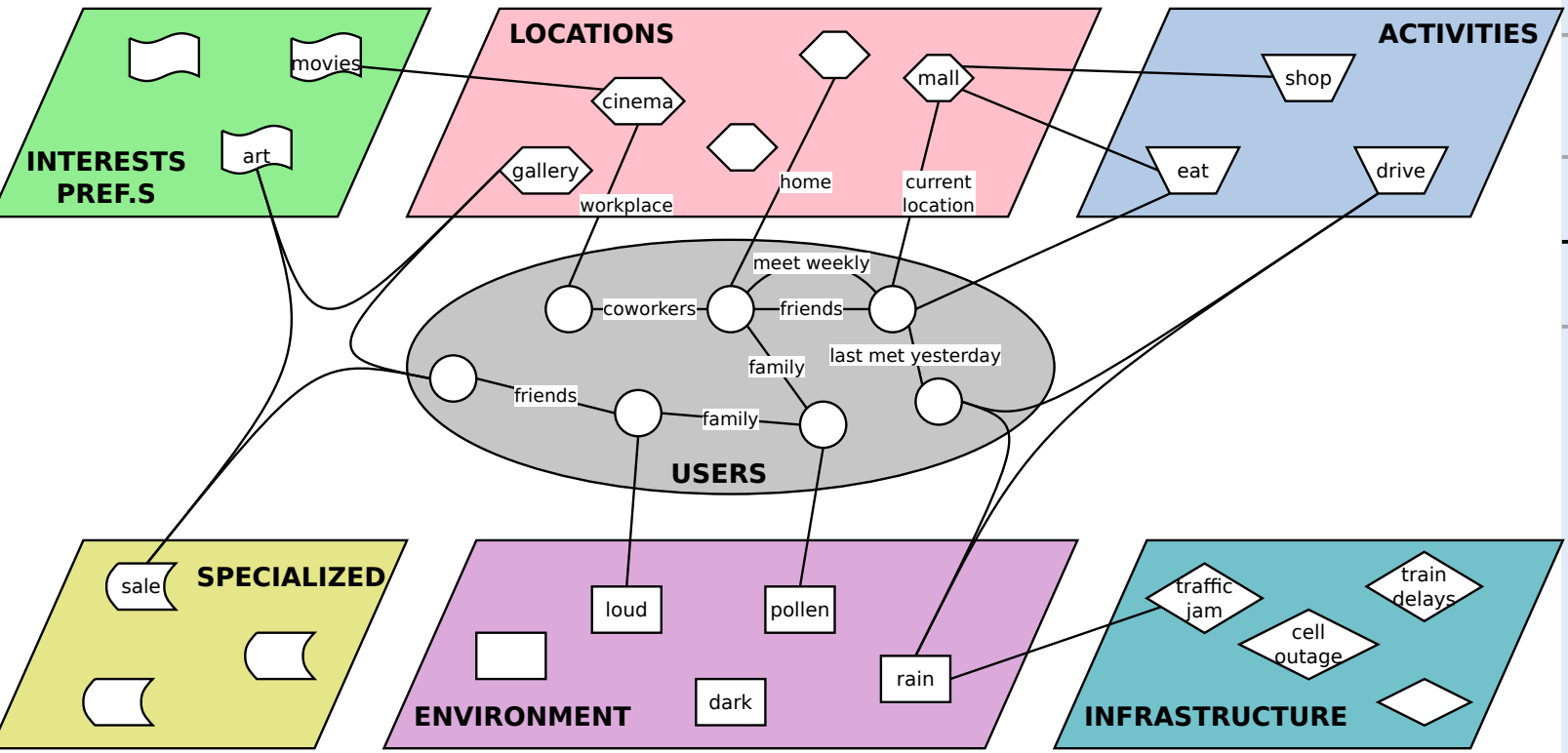
User ↔ Context Graph

- Multi-mode – many types of nodes
- Multi-plex – many types of links
- Hypergraph?

Challenges:

- Empirical exploration (small world, scale free etc.)
- Time varying – many time scales
- Efficient implementation (e.g. Neo4j)
- etc

User ↔ Context Graph



Using the insights

Dense LTE femtocell deployment – **challenges**:

- intractable list of neighbor cells,
- unnecessary handovers,

- high energy consumption,
- lower capacity than larger cells,
- interference etc,

- access control.

Using the insights: handovers

Location/Mobility Prediction for Handovers

- Mobility prediction: statistical vs. inertial
- Next cell prediction ⇒ handover speed-up, resource reservation etc.
- Both studied extensively!

Using the insights: handovers

Location/Mobility Prediction for Handovers

- Mobility prediction: statistical vs. inertial
- Next cell prediction ⇒ handover speed-up, resource reservation etc.
- Both studied extensively!

Trying to reinvent the wheel?

Adapting and Improving the Wheel!

Femtocells – new characteristics, new challenges:

- smaller area ⇒ lower sojourn time,
- indoors (walls) ⇒ difficult cell border conditions,
- high mobility users especially problematic...

TODO

Mobility prediction:

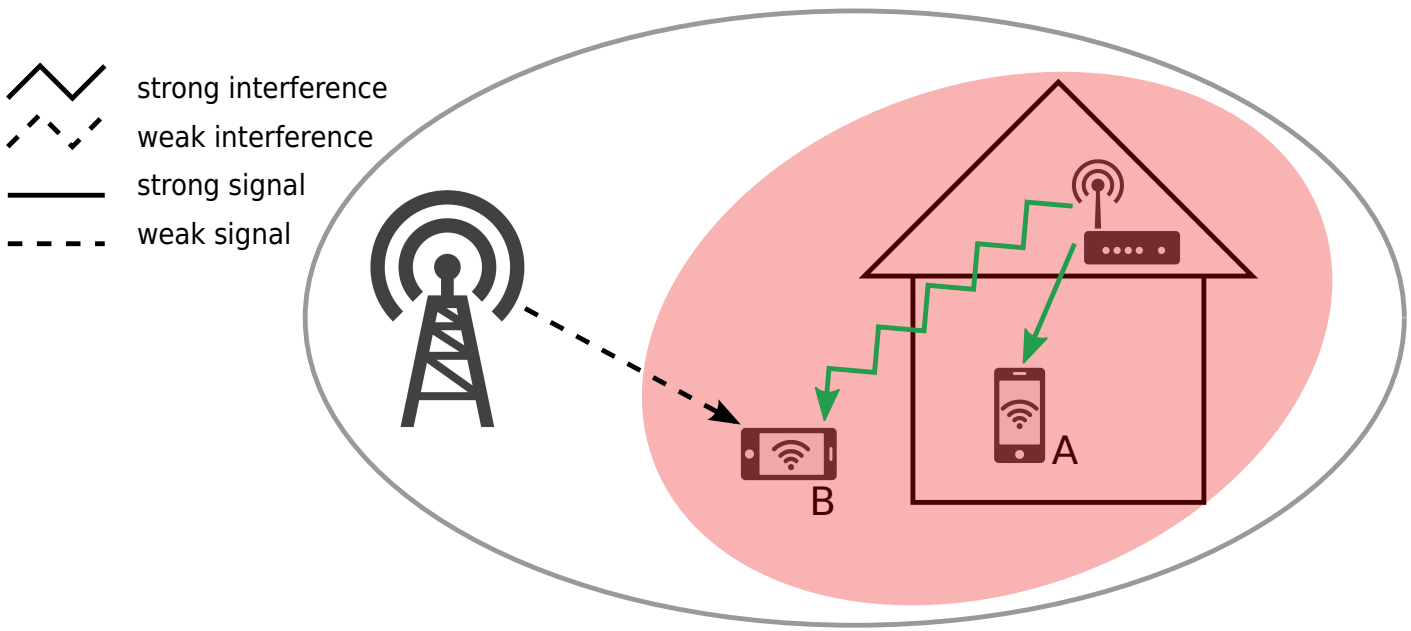
- what kind of mobility information is relevant?
- what accuracy is expected?
- is outdoor mobility prediction sufficient?

Handover strategies:

- existing algorithm(s) for the femtocell challenge?
- room for improvement in these algorithms?
- needed prediction accuracy for the improvement?

Using the insights: Access to Femtocells

- Current options: open, closed, hybrid.
- Inflexible, maybe even problematic...
- Better: location-based access control.



Conclusions

The SwissSenseSynergy project:

- jointly mining data from a variety of sources
- predict user mobility and behavior
- use predictions for better location-based services
- ... and for tackling various LTE challenges